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SURVEY OF THREE STEEP GRADIENT REFERENCE STREAMS IN NORTHERN IDAHO



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ABSTRACT

Steep gradient streams are typically first to second order streams in V-shaped valleys on slopes where the gradient exceeds 9%. The water in the streams is cold and the temperature remains somewhat constant over the year. These headwaters are significantly influenced by riparian vegetation because the ratio of shoreline to stream bottom area is high and because tree growth provides shade and organic input. The streams selected as references to provide baseline monitoring sites were staked in order to recognize them at a later date. Canyon Creek and Shoshone Tributary are both located in Research Natural Areas (RNA) and Twin Creek on private land. A habitat assessment showed the streams to be relatively unimpacted. The two RNA drainages scored highest in certain instream, morphological and riparian categories. Conductivity, alkalinity and nutrient values were all low in the water and pH circumneutral. Total abundance, taxa richness, percent EPT and EPT richness of macroinvertebrates were higher in the RNA streams and the biotic index lower. Shredders, scrapers and predators were the most common functional types collected. *Cryptochia pilosa* a small rare caddisfly was collected in all of the streams. A comparison between similarity of aquatic invertebrates collected from Shoshone Tributary in 1976 and Canyon Creek in 1977 with those in 1993 was 73% and 62%, respectively, which indicates that these RNAs have not been disturbed much over this period of time.

Survey of Three Steep Gradient Reference Streams in Northern Idaho

INTRODUCTION

A classification of natural area stream types among first to fourth order streams is characterized by flow, gradient and substrate differences (Rabe and Savage 1977, Savage and Rabe 1978). These are: low gradient, meandering glide; moderate gradient, riffle pool; and steep gradient, torrential. Ephemeral streams and those with a major spring source are also recognized.

Two of the steep gradient streams in this study were preserved as natural areas and one flows across private land. Natural areas are small tracts of land and water set aside to preserve undisturbed ecosystems for biodiversity conservation and as baseline or reference sites for resource management (Savage 1978). The Idaho Natural Area Coordinating Committee working with different agencies and organizations continues to establish statewide network of these reserves (Habeck 1988; Hilty and Moseley 1991). Types of natural areas included in the network are Research Natural Areas (RNA) managed by the USDA Forest Service, Areas of Critical Environmental Concern (ACEC) by the Bureau of Land Management and Nature Conservancy Preserves. The two stream natural areas in this study are RNAs.

A reference stream represents the best habitat and water quality conditions attainable for the region or watershed (Klemm 1990). Reference streams where no roading, logging or mining have occurred have been used in Idaho to compare with impacted sites (Rabe and Cazier 1992; Hoiland and Rabe 1991; Rabe et al. 1993; Moseley et al. 1993; Hoiland et al. 1994).

The objectives of this study were to update and expand on the knowledge of steep gradient streams in northern Idaho by comparing habitat assessment, water chemistry and macroinvertebrate communities in three different streams and to establish baseline monitoring sites there. In addition, information collected 16-17 years ago in these streams is compared with present data.

DESCRIPTION OF AREA

Steep gradient (Type 3) streams are typically first or second order streams in young, V-shaped valleys on steep slopes (gradient exceeds about 9%) and exhibit a cascade-pool pattern of flow (Savage and Rabe 1979). Bedrock may be exposed in the channel due to the predominance of erosion to deposition. The water is cold in these streams and the temperature somewhat constant over the year.

Shading of higher elevation streams often occurs due to steep side slopes and dense forests along the banks. These headwaters are significantly influenced by riparian vegetation because the ratio of shoreline to stream bottom area is high and because tree growth provides shade and organic input (Cummins 1977).

Large woody debris from the overgrowth is responsible for two habitats in these streams - the wood itself and wood created environments such as debris pools (Franklin et al. 1981). The rocky conditions of the substrate characterize a third habitat where fast water occurs.

According to Franklin et al. 1981, moss cover in first to second order streams in the Pacific Northwest generally exceeds 20% of the surface area (Figure 3A-B).

Twin Creek, which lies in T40N, R4W, S18, drains the west slope of Moscow Mountain in the Palouse Range about three miles north of Moscow, Idaho. The granitic range is associated with the late Cretaceous early Tertiary uplift of the Idaho batholith (Ross and Savage 1967). Twin Creek is on private land, Physical, chemical and biological data was collected during September 1967 and July 1993.

The stream has its source at an elevation of 1350-1700 m and is fed by surface runoff and springs or seeps. Below 1600 m there is water in the stream year-round even after months of negligible rainfall. Twin Creek flows generally east to west and joins Crumarine Creek which then drains into the South Fork of the Palouse River.

The creek is in a V-shaped gorge with cedar (*Thuja plicata*) and grand fir (*Abies grandis*) growing densely along the bank. Much deadfall from the trees forms debris dams and contributes fine organic material to the stream bed (Figure 1A). Small shallow pools exist where boulders along the border provide support for woody material backing up the water (Figure 1B). Fast water is the most common flow, especially during snowmelt when high water conditions exist and the creek is torrential.

The reach is about 33 m in length. An old man-made dam is at the bottom of the study section and a 1 1/2 m falls at the top. Width/depth ratio in m was 4.8.

An unnamed tributary within the **Upper Shoshone Creek RNA** drains the west slope of the Bitterroot Range (T53N, R4E, S29, 30, 31 32). Directional aspect of the watershed is southwest. The stream empties into Shoshone Creek, a tributary of the North Fork of the Coeur d'Alene River. The channel occupies a V-shaped valley with steep side slopes underlain by Precambrian Belt series rock.

The Upper Shoshone Creek RNA encompasses an entire small drainage. The main channel is a second order stream 2.4 km in length. Three first order streams total another 4 km. Elevation varies from 1190 m at the mouth to 1725 m at the source. Gradient increases from 8% near the mouth to 17% at the confluence of the first order tributaries. Physical, chemical and biologic data was collected during November 1975 and July 1993.

The reach sampled begins about 20 m above where the stream enters Shoshone Creek and extends upstream about 80 m. The channel here is bordered by very dense stands of trees and shrubs. Western hemlock (*Tsuga heterophylla*) is a forest community type found at streamside and lower slope positions (Wellner 1976).

In reference to the stream classification by Hawkins 1993, much of the turbulent fast water habitat was observed as rapids. This very fast moving section of the stream caused by

increased gradient is seen in Figure 2A. An example of a backwater dammed pool is shown in Figure 2B and a cascade and debris dammed pool in Figure 2D. Other habitats noted were riffles, runs and the debris dammed pools (Figure 2C). The width/depth ratio in m was 8.2.

A prominent bedrock waterfall about 1.8 m high is located approximately 0.6 km above the mouth of the stream (not in our study area). Here turbulent fast flow habitats were mostly cascades. This area was very difficult to reach. As a result we chose to sample the more accessible site downstream from the cascades.

Upper Canyon Creek drainage (T58N, R3W, S20) is contained in the Canyon Creek Research Natural Area. It is a tributary of the Priest River. The geology consists mostly of granitic (quartz monsonite) bedrock of the Selkirk Crest pluton. The site was collected in July 1976 and July 1993.

The site studied is a first order perennial stream at an elevation of 1450-1700 m fed by surface runoff and springs or seeps. It has an average gradient of 20%. The length of the reach is 110 m. The steep sided banks and canopy provide ample shade to the stream.

The V-shaped gorge is bordered by an old growth forest consisting mainly of western red cedar (*Thuja plicata*) and hemlock (*Tsuga heterophylla*). Deadfall from the above canopy, together with rock material in the channel, are responsible for pool formation. According to Hawkins et al. 1993, plunge pools are formed by an obstruction such as boulders or sheetrock (Figures 3A-B) and debris dammed pools by woody material (Figure 3C).

The turbulent fast water habitats (Hawkins et al. 1993) are predominantly cascades or series of small waterfalls over steep rock (Figures 3A-B). At the lower end of the reach, cascades are not as high and pools are wider and longer in length as gradient decreases (Figure 3D). The width/depth ratio in m was 13.6.

METHODS

Habitat assessment, water quality and macroinvertebrates were collected from the three steep gradient streams on July 18-21, 1993. The stream reaches sampled were staked in order to recognize them at a later date.

Stream velocities were measured with a Digital Flowmeter (Model 2030) and regression based on counts/second. Width and depth were measured with a tape and meter stick. Substrate, percentage of organic debris, riparian vegetation and bank condition were optically observed. Gradients were estimated using a tape and rod at each station.

The habitat assessment methodology was developed from Plafkin 1989. The three main categories evaluated were instream, morphology and riparian. Instream characteristics observed were different substrate size classes, different categories of substrate (mineral, macrophyte, coarse particulate organic matter) and embeddedness. Morphology observations consisted of channel shape, channel alteration, bank stability and combinations of gradients

and retention structures. Riparian characteristics evaluated were diversity, condition and stage of succession. The criteria for each category is listed in Appendix I.

Each of the ten sub-categories was evaluated as follows: excellent condition 10-12 points, good condition 7-9 points, fair condition 4-6 points, poor condition 1-3 points. The point range allowed judgement of the observers to account for subjectivity relative to other evaluators. The highest possible total score for a site was 120 points. An excellent score ranged from 91-120, good score 61-90, fair score 31-60 and poor score 0-30.

Terms describing flow are incorporated into the physical description of the three steep gradient streams (Hawkins et al. 1993). These are slow water (scour plunge pools, debris dammed pools) and fast turbulent water (falls, cascades, rapids, riffles). Some of these flow types are illustrated in Figures 1-3.

Temperature was taken with a standard field thermometer. Alkalinity was performed by titrating 100 ml samples with 0.02 N sulfuric acid using methyl orange as an indicator. Conductivity was taken using a YSI Model 33 conductivity meter. Total dissolved solids, turbidity, nitrates, phosphates and various cations were analyzed by the University of Idaho Analytical Laboratory, Holm Research Center, Moscow, Idaho. Fecal coliform counts were determined by personnel from the Moscow Sewage Treatment Plant.

Macroinvertebrates were collected from three stratified habitats-riffle, pool and CPOM (Coarse particulate organic matter). The CPOM was sampled from marginal and depositional areas of both pools and riffles and placed in medium size zip-lock bags. The D-net method was used to collect pools and riffle areas. The amount sampled this way was 0.1 sq m. Five samples were collected from each habitat in each stream for a total of 15 samples per stream. They were placed in zip-lock bags and kept cool. At the lab, samples were sorted, enumerated and then put in 70% ethanol. Identification was to the lowest possible taxonomic level.

This information was used to calculate various biological community analysis measurements (metrics). These metrics describe the biological integrity or structure, function and composition of a macroinvertebrate community. Our approach was a modified version of Rapid Bioassessment Protocol 3 developed by the EPA (Klemm 1990, Plafkin et al. 1989). Sampling is non-random and absolute estimates of abundance are not considered, but rather "who is there and who is not there" (Wisseman 1993). A number of bioassessment protocols exist and they no doubt will continue to be refined over the years.

The following metrics were calculated: taxa richness, EPT index or the total number of three insect orders (Ephemeroptera, Plecoptera, Trichoptera) found in the sample, Hilsenhoff Biotic Index or the tolerance value of each taxa and percentage of functional types present to include scrapers, collectors (gatherers and filterers), shredders and predators. In addition, the Shannon/Wiener species diversity was calculated which describes the interaction of taxa richness and evenness (number of individuals comprising each taxa).

A similarity analysis of Canyon Creek, Twin Creek and Shoshone Tributary was completed between the average stream communities observed and the three different habitats (riffle,

pool, CPOM) using the species taxonomic level. Riffle here is used to represent all the fast water flow types (cascades, rapids, riffles, runs) and CPOM is synonymous with woody debris. Pools were sampled along shore (backwater pools or margins) and in the main channel.

Community similarity analysis was also determined between macroinvertebrates collected from Canyon Creek in 1976 and 1993 and Shoshone Creek Tributary in 1975 and 1993. A family taxonomic level was used to calculate similarity analysis since identification of many genera to new species have occurred over this amount of time. Collection of macroinvertebrates in Twin Creek was not made in 1967 so no comparison between samples collected in 1993 was possible.

Voucher collections of the macroinvertebrates from Shoshone Tributary and Canyon Creek were deposited with the O.J. Smith Museum of Natural History at the Albertson College of Idaho in Caldwell, Idaho.

RESULTS AND DISCUSSION

Habitat

Habitat assessment scores are presented in Table 1. The criteria for each category is listed in Appendix 1. All three streams were relatively undisturbed. Scores were 91, 110 and 110 for Twin Creek, Shoshone Tributary and Canyon Creek, respectively. Twin Creek is impacted in places by a well used trail adjacent to the bank which allows levels of sediment to enter the stream. There is also some disturbance to the riparian vegetation. Canyon Creek scored high because of the instream substrate diversity. Shoshone Tributary scored high in the riparian category where more mix of deciduous and coniferous vegetation occurred. In addition, there was no trail along either Shoshone Tributary and Canyon Creek. However, it was easier to walk in or along Canyon Creek since the old growth vegetation was more spaced as compared to Shoshone Tributary where the water was swift and deep in places and vegetation dense along the banks.

Additional information about habitat is found in the Description of Area section and Figures 1-3.

Water Chemistry and Velocity

Samples from the three streams were somewhat similar as to water quality (Table 2). Alkalinity was (2-11 mg/l). Readings less than 50 mg/l are considered low as a rule (Yee 1991). The pH values (7.1-7.3) indicate circumneutral conditions. Conductivity was also low (12-30 micromhos/cm). Total dissolved solids (54-93 mg/l) were higher than expected since these readings reflect concentration of calcium and magnesium ions which were low in amount. In addition, nutrients (nitrates and phosphates) were beyond detectable limits (BDL) or low in amount where they occurred. Alkalinity, pH and conductivity readings taken at the earlier dates were quite similar to the 1993 data. The water then was not analyzed for hardness and nutrients.

The most common cations were calcium, magnesium and potassium. In 1976 zinc readings in Shoshone Tributary stream measured 0.2 mg/l which is about ten times that of other unimpacted northern Idaho waters analyzed. Zinc reading in Shoshone Tributary in 1993 were BDL. No explanation to explain the earlier reading can be given except that this drainage is not too far from the Coeur d'Alene mining district. Cations were not measured at the earlier dates in the other two streams.

Turbidity of the three streams was quite low and light transparency high (Figure 2B). Fecal coliform counts were low as expected. Temperatures ranged from 4-12 degrees C. The heavy shading of the old growth forest bordering Canyon Creek was thought to be responsible for the lower temperature. Also, a cold spring a short distance upstream is the source of Canyon Creek. The temperature of the water in Canyon Creek in 1977 was 5 degrees C. The water velocity readings in Shoshone Tributary averaged 1.2 m/s. Velocities in Canyon Creek and Twin Creek, respectively, were 0.8 and 0.5 m/s. Velocity readings were not taken at earlier dates, but there did not appear to be much difference then and now.

Macroinvertebrates

A list of taxa observed in July 1993 in each stream is presented in Macroinvertebrates Appendix II. Most all the macroinvertebrates are insects except for some flatworms (Platyhelminthes), aquatic earthworms (Oligochaeta) and water mites (Hydracarina). A listing of taxa found by stream and habitat (riffle pool, CPOM) is seen in Appendix III.

The five individual samples of metric values analyzed for macroinvertebrate communities in each stream by habitat are shown in Appendix IV. Average metric values for each stream by habitat and average values for each stream are presented in Table 3.

The average total abundance is three to four times higher in Canyon Creek than the other two streams. Riffle abundance of macroinvertebrates is much higher than pool and CPOM habitat in both Shoshone Tributary and Canyon Creek whereas CPOM abundance is slightly higher in Twin Creek (Table 3). Velocity and volume of flow are much less in Twin Creek so that the riffle habitat is probably not as rich. In addition, water hydraulics are stronger especially in Shoshone Tributary so that the substrate is well aerated and kept mostly clear of fine sediment (Wisseman 1993).

The total number of taxa collected in Shoshone Tributary was 38. Thirty-three taxa were sampled in Canyon Creek and 24 from Twin Creek. Most of the taxa were observed in riffle habitat from Shoshone Tributary and Canyon Creek. Macroinvertebrate taxa were somewhat equally distributed in the Twin Creek habitats. Pools yielded the fewest taxa in all three streams. This number of total species is quite low compared to western Cascade streams where species abundance is much higher (Wisseman 1993). *Cryptochia pilosa* a small rare caddisfly was collected in all three streams.

Taxa richness of macroinvertebrates from the study streams compares favorably with other reference streams in the region. This includes the North Fork of the Coeur d'Alene River (Holland et al. 1994) and tributaries of the North Fork (Hoiland and Rabe 1992).

Species diversity which takes in account both the number of species and the evenness of occurrence of individuals in the various species was about the same for all three streams. Compared with other reference streams in the region, species diversity readings were relatively low because of the dominance of a few taxa in the communities. This included *Yoraperla brevis* a stonefly which overall was the most dominant taxa in all three streams. *Neothremma* sp. was dominant in Canyon Creek pools and *Glossma* sp. in Shoshone Tributary pools.

The percent sample consisting of mayflies, stoneflies, caddis flies or the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) ranged from 41-69% (Table 3). Many of these species are very intolerant to stress, though some tolerant forms exist. Streams having macroinvertebrate communities comprised of a high percentage of EPT such as occurs in this study are associated with clean water and an unimpacted habitat. In contrast, no EPT at all occur in northern Idaho streams where heavy metal pollution and other extreme perturbations exist (Hoiland and Rabe 1991), Hoiland and Rabe 1992, Hoiland et al. 1993, Rabe et al. 1993).

The EPT in the riffle habitat of Canyon Creek and Shoshone Tributary amounted to 90-97% of the entire macroinvertebrate community. About half of the individuals in the riffles of Twin Creek were EPT species.

The total number of EPT species in Shoshone Tributary, Canyon Creek and Twin Creek were 30, 23 and 12 in that order. The lower number of EPT species in Twin Creek was probably due to the smaller first order stream and the fact there was less heterogeneity of debris and mineral substrate in the channel. The number of EPT species in Canyon Creek and Shoshone Tributary compared favorably with EPT numbers in the North Fork of the Coeur d'Alene River and exceeded the number in two tributaries of the Coeur d'Alene (Hoiland et al. 1993, Hoiland and Rabe 1991).

The highest number of EPT species was found in the riffle habitat of Shoshone Tributary and Canyon Creek. The riffle and debris habitat samples had the highest number of EPT in Twin Creek.

The Hilsenhoff Biotic Index describes the tolerance of macroinvertebrate taxa to organic pollution, warm water, fine sediment and heavy filamentous algae. The range of values is from 1-10. Organisms having a value of 0 are very intolerant to stress whereas those with values over 6 exhibit high tolerance. The average biotic index for the three streams ranged from 1.7 to 2.5. The lowest habitat value was 1.4 for pools. These numbers indicate that the macroinvertebrate communities, as a whole, are very sensitive to perturbation.

Some very intolerant stoneflies (value 0) found in the streams were *Despaxia augusta*, *Paraleutra* sp. *Zapada columbiana*, *Setvena bradleyi* and *Yoraperla brevis*. Caddis flies and stoneflies are more sensitive to perturbation than mayflies.

Functional feeding group identity of aquatic invertebrates is another metric that helps determine the biological wholeness of the community. If all feeding types are well

represented, then the community reflects a healthy situation as compared to streams with only a few functional types to fill fewer niches.

Approximately half the organisms sampled from Twin Creek were shredders. These utilize coarse particulate organic matter from the canopy. Most were collected in the CPOM. The percentage composition of shredders in Shoshone Tributary and Canyon Creek was less than Twin Creek, however, the majority was collected from CPOM.

According to Hawkins et al. 1981, canopy type is more important than substrate in influencing abundance of organisms. The study also found that neither canopy or substrate strongly influenced number of taxa. *Yoraperla brevis* and *Zapada columbiana* are stonefly shredders sampled from all three streams. Shredders are primarily stoneflies and caddisflies.

It was surprising then to find a greater percentage of scrapers than shredders in Shoshone Tributary and Canyon Creek. Scrapers scrape algae and detritus off rocks. The substrate was well shaded, especially in Canyon Creek, and the feel of the rocks did not indicate much plant growth on them. *Cryptochia pilosa*, a caddisfly, is a scraper-shredder found in all three streams.

Collector-gatherers which utilize fine particulate organic matter in the water column and off the bottom showed the smallest percentage of organisms in Shoshone Tributary and Canyon Creek. *Cinygmula* sp., a stonefly is a scraper and collector-gatherer. *Neothremma* sp., a caddisfly is a collector. Both occurred in all three streams. Insignificant numbers of collector-gatherers are found in streams bounded by heavily shaded forests (Wisseman 1993).

About 30% of the organisms comprising the community were predators in Shoshone Tributary and Twin Creek and 12% from Canyon Creek. Three species of the family Rhyacophilidae which are caddisflies and *Stvena bradleyi* which is a stonefly were found in all three streams as predators. According to Wisseman 1993, unimpacted montane streams usually have a large number of predators.

In addition to the above functional groups, invertebrates that actually eat wood (xylophages) were found in the streams. These included a mayfly, *Cinygma* sp. a beetle, *Lara avara*, and a caddisfly, *Cryptoclia pilosa*.

Wisseman (1993) defines the "ideal" mid-montane stream as having a macroinvertebrate community comprised of mainly cool adapted, rheophylic taxa (preference to living in fast water). Some characteristics he mentions that apply mostly to steep gradient streams are the habitat would consist of a dense riparian overstory providing heavy shading to the channel, a moderate to high gradient, high roughness of substrate, much bole wood present to increase habitat complexity, high input of leaves and needles, low inputs of sediment and high amount of crevice space around and under rocks.

Similarities of taxa in the three stream communities is presented in Table 4. As noted, there is a greater similarity between communities in Shoshone Tributary and Canyon Creek than between Shoshone Tributary and Twin Creek or Canyon Creek and Twin Creek. As pointed

out above, Twin Creek is much smaller than the other two drainages and has less mineral and wood heterogeneity.

A comparison between similarity of aquatic invertebrates collected from Shoshone Tributary in 1976 and Canyon Creek in 1977 with those in 1993 is shown in Table 5. This comparison was made at the family level because many of the taxa collected in 1976-77 were only keyed to family. Since then, taxonomic knowledge has increased to where most organisms now are keyed to genus or species. In Shoshone Tributary, 23 families were observed in 1993 and 19 in 1975. Seventeen of these were identical families so that the similarity between these dates was 73%. In Canyon Creek, 20 families were identified in 1993 and 13 in 1977. The similarity of taxa was 62%.

These similarities of aquatic invertebrate communities collected 16-17 years ago with present forms is considered quite high especially since a number of variables have to be considered. These include different people making the collections, slightly different methods and seasonal differences. The similarities also indicate that the streams have not been disturbed much over this period of time.

TABLE 1. Habitat assessment for three steep gradient streams in Northern Idaho.

Habitat/Parameters	TWIN	SHOSHONE	CANYON
INSTREAM			
Heterogeneity	9	10	12
Quantified	10	10	10
Condition	8	9	11
MORPHOLOGY			
Channel Shape	9	11	11
Alteration	8	12	12
Bank Stability	10	12	12
Complexity	8	11	11
RIPARIAN			
Diversity	9	12	9
Natural/viable	10	12	12
Status	10	12	10
TOTAL	91	110	110

Instream heterogeneity: different categories of substrate, e.g., mineral, macrophyte, CPOM, LWD.

Instream quantification: different substrate size classes.

Instream condition: presense and depth of fines or embeddedness.

Mophological channel shape: boxed, veed and number of bends.

Mophological alterations: extent to which channel appears undisturbed.

Mophological bank stability: percent of bank in stable mode.

Mophological complexity: combinations of gradients and retention structures.

Riparian diversity: types of vegetation, e.g., ferns, shrubs, trees, etc.

Riparian condition: is it natural, original or introduced.

Riparian status: is the riparian community new or at climax status or inbetween.

TABLE 2. Selected physical and chemical factors of three steep gradient streams in northern Idaho.

	TWIN CREEK	SHOSHONE TRIBUTARY	CANYON CREEK
Temperature (c)	12	7	4
Velocity (m/sec)	0.5	1.2	0.8
pH	7.3	7.1	7.2
Conductivity (micromhos/cm)	30	28	12
Turbidity (NTU)	3.0	3.0	1.0
Total dissolved solids (mg/l)	93.0	56.0	54.0
Alkalinity (mg/l)	11.0	5.0	2.0
Nitrate/nitrite (mg/l)	BDL*	BDL	0.2
Ortho phosphorus (mg/l)	0.05	BDL	BDL
Calcium ($\mu\text{g/ml}$)	3.1	3.0	4.4
Magnesium ($\mu\text{g/ml}$)	0.6	1.3	0.4
Potassium ($\mu\text{g/ml}$)	0.9	0.8	BDL
Sodium ($\mu\text{g/ml}$)	3.5	BDL	BDL
Aluminum ($\mu\text{g/ml}$)	BDL	BDL	BDL
Barium ($\mu\text{g/ml}$)	0.009	0.01	0.006
Iron ($\mu\text{g/ml}$)	0.04	BDL	BDL
Zinc ($\mu\text{g/ml}$)	BDL	BDL	BDL
Fecal coliform (collonies/100 ml)	4.0	> .01	0.02

*BDL is beyond detectable limits.

TABLE 3. Average metric values of macroinvertebrate communities in three steep gradient streams and three habitats comprising each stream.

	1	2	3	4	5	6	7	8	9	10
Twin Creek										
Riffle	77.2	15	1.67	0.48	9	2.56	0.60	0.00	0.25	0.15
Pool	40.3	13	1.21	0.20	5	2.83	0.22	0.02	0.21	0.54
CPOM	91.1	15	1.18	0.56	9	2.23	0.71	0.01	0.02	0.24
Shoshone Tributary Creek										
Riffle	141.9	32	2.39	0.90	24	1.75	0.25	0.24	0.09	0.40
Pool	42.3	7	0.76	0.58	5	1.69	0.00	0.51	0.08	0.02
CPOM	95.7	12	1.40	0.60	9	1.53	0.37	0.00	0.01	0.57
Canyon Creek										
Riffle	578.8	28	2.16	0.97	21	1.83	0.51	0.24	0.04	0.16
Pool	69.3	12	0.54	0.63	8	1.37	0.01	0.03	0.03	0.02
CPOM	62.1	20	1.71	0.39	12	2.00	0.56	0.14	0.14	0.18
Metric Average Per Stream										
Twin	69.7	24	1.36	0.41	12	2.54	0.51	0.01	0.16	0.31
Shoshone	93.3	38	1.57	0.69	30	1.66	0.21	0.06	0.06	0.33
Canyon	236.7	33	1.47	0.66	23	1.73	0.36	0.41	0.07	0.12

1. Total abundance for square meter of substrate.
2. Total number of taxa collected.
3. Shannon/Wiener species diversity.
4. Percent of sample consisting of Ephemeroptera, Plecoptera and Trichoptera.
5. Number of species in the orders Ephemeroptera, Plecoptera and Trichoptera.
6. Hilsenhoff Biotic Index, lower values indicate higher ecological conditions in relation to organic levels.
7. Percent of sample from the trophic guild of shredders.
8. Percent of sample from the trophic guild of scrapers.
9. Percent of sample from the trophic guild of collectors.
10. Percent of sample from the trophic guild of predators.

TABLE 4. Community similarity indices by total unique and similar taxa of three steep gradient streams in northern Idaho.

A-Stream to B-Stream	A-Stream Total	B-Stream Total	A-Stream Unique	B-Stream Unique	A & B-Shared
Shoshone Tributary to Twin Creek	38	24	25	11	13
Shoshone Tributary to Canyon Creek	38	33	18	13	20
Canyon Creek to Twin Creek	33	24	23	14	10

TABLE 5. Family similarity analysis of Shoshone Tributary and Canyon Creek between 1976-77 (past dates) and 1993 (present).

Stream	Present Total	Past Total	Present Unique	Past Unique	Common
Shoshone Tributary	23	19	5	2	17
Canyon Creek	20	13	5	1	12
Similarity					
Shoshone Tributary	0.73				
Canyon Creek	0.62				



Figure 1b. Deadfall comprising debris dammed pool on Twin Creek



Figure 1a. Cascade and plunge pool on Twin Creek



Figure 2a. Rapids on Shoshone Tributary
Note scarcity of pools



Figure 2b. Backwater dammed pool
on Shoshone Tributary. The plant is
Devil's Club (*Oplopanax horridum*)



Figure 2c. Riffle, debris dammed pool and run on Shoshone Tributary



Figure 2d. Cascade and debris dammed pool on Shoshone Tributary



Figure 3a. Cascades and plunge pools of Canyon Creek. Notice abundance of moss on rocks

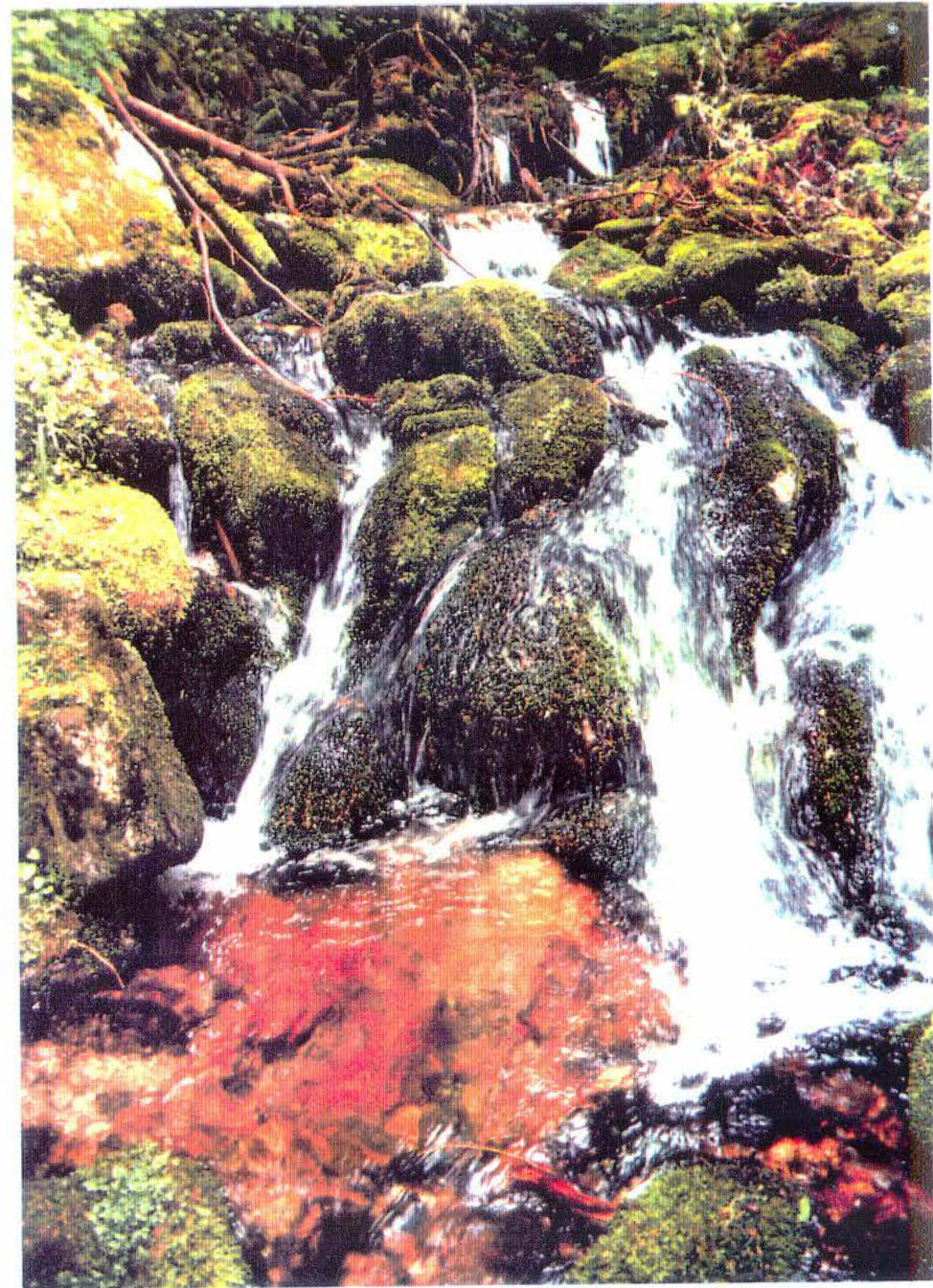


Figure 3b. Cascades and plunge pool of Canyon Creek



Figure 3c. Debris dams on Canyon Creek

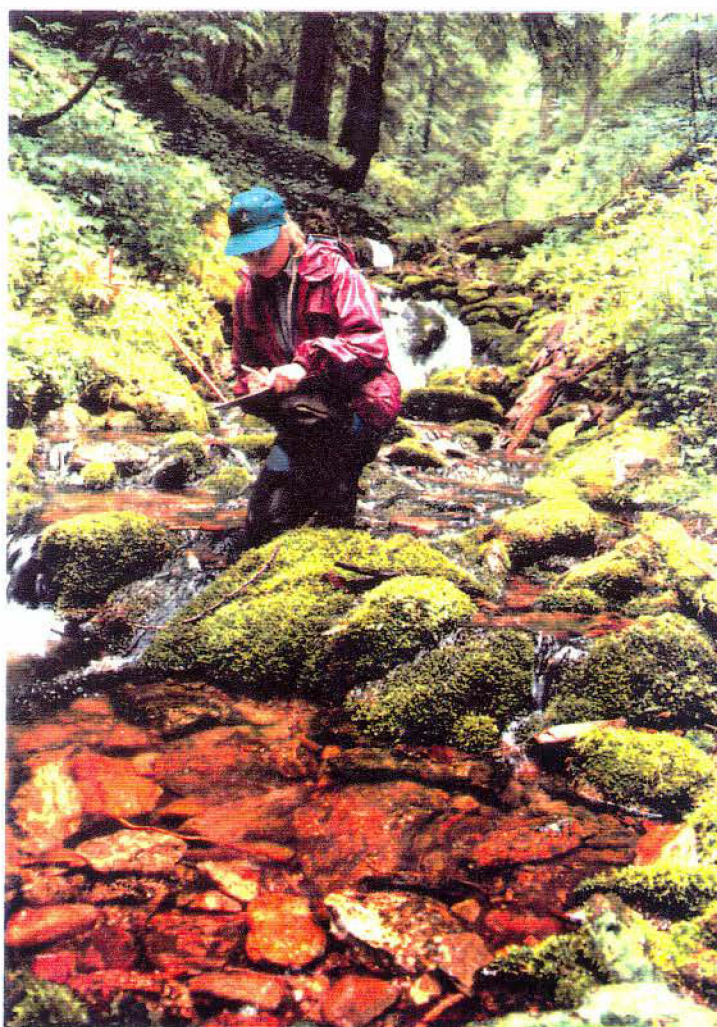


Figure 3d. Backwater pool on Canyon Creek

LITERATURE CITED

- Cummins, K. 1977. From headwater streams to rivers. *American Biology Teacher*, May, 41-48.
- Franklin, J.F., K. Cromack, W. Denison, A. McKee, C. Maser, J. Sedell, F. Swanson and G. Juday 1981. Ecological characteristics of old growth Douglas Fir forests. USDA Forest Service Rpt. PNW 118, 48 p.
- Hawkins, C.P., J.L. Kershner, P.A. Bisson, M.D. Bryant, L.M. Decker, S.V. Gregory, D.A. McCullough, C.K. Overton, G.H. Reeves, R.J. Steedman and M.K. Young 1993. A hierarchical approach to classifying stream habitat features. *Fisheries* 18(6):3-10.
- Hawkins, C.P., M.L. Murphy and N.H. Anderson 1982. Effects of canopy, substrate composition and gradient on the structure of macroinvertebrate communities in Cascade Range streams of Oregon, *Ecology* 63(6):1840-1856.
- Hilty, J. and R.K. Moseley 1991. Idaho National Areas Directory. Conservatory Data Center, Idaho Department of Fish and Game, Boise, Idaho, 212 p.
- Hoiland, W.K., F.W. Rabe, R.C. Biggam 1994. Recovery of macroinvertebrate communities from metal pollution in the South Fork and mainstem of the Coeur d'Alene River, Idaho. *Water Environment Research* 66(1):84-88.
- Hoiland, W.K. and F.W. Rabe 1992. Effects of zinc levels and habitat degradation on macroinvertebrate communities in three north Idaho streams 1992. *Journal of Freshwater Ecology* 7(4):373-380.
- Hoiland, W.K. and F.W. Rabe 1991. Effect of placer mining on selected streams in the Wallace Ranger District of Idaho. USDA Forest Service, Wallace Ranger District, Wallace, Idaho, 32 p.
- Habeck, J.R. 1988. Research Natural Areas in the Northern Region: A guidebook for scientists and educators. U.S. Forest Service, Intermountain Research Station, Missoula, Montana, 124 p.
- Klemm, D.J., P.A. Lewis, F. Fulk and J.M. Lazorchak 1990. Macroinvertebrate field and lab methods for evaluating the biological integrity of surface/waters, EPA/600/4-90/030, 256 p.
- Moseley, R.K., R.J. Bursik, F.W. Rabe and L.D. Cazier 1994. Peatlands of the Sawtooth Valley, Custer and Blaine Counties, Idaho. Idaho Department of Fish and Game, Boise, Idaho, 63 p.
- Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes 1989. Rapid bioassessment protocols for use in streams and rivers, EPA/444/4-89/001.

- Rabe, F.W. and L.D. Cazier 1993. A comparison of habitat assessment and macroinvertebrate communities from Schwartz Creek in October 1991 and 1992. USDA Forest Service Palouse Ranger District, Idaho, 25 p.
- Rabe, F.W., L.D. Cazier, A.R. Thornbrough, J.W. Shuman, C.H. Luce and J. Bell 1993. Habitat assessment and bioassessment of Paradise Creek and the Palouse River at selected sites in Idaho and Washington, Palouse Conservation District, Pullman, Washington, 77 p.
- Rabe, F.W. and N.L. Savage 1977. Aquatic natural areas in Idaho. Idaho Water Resource Research Institute, University of Idaho, Moscow, 103 p.
- Ross, S.H. and C.N. Savage 1967. Idaho earth science. Idaho Bureau of Mines and Geology, Earth Sciences Series 1, Moscow, Idaho, 271 p.
- Savage, N.L. and F.W. Rabe 1979. Stream types in Idaho: An approach to classification of streams in natural areas. *Biological Conservation* 15:301-315.
- Savage, N.L. 1978. The Idaho Natural Areas Program. *Journal of Idaho Academy of Science* 14(1):11-23.
- Wellner, C.A. 1976. Establishment report for Upper Shoshone Creek Research Natural Area within Coeur d'Alene National Forest, Idaho, USDA Forest Service, 17 p.
- Wisseman, B. 1993. Benthic invertebrate bioassessment. Aquatic Biology Associates, Corvallis, Oregon, 15 p.
- Yee, B. 1991. The aquatic invertebrate monitoring program. Friends of Environmental Education Society of Alberta, FEESA, Alberta, Canada, 132 p.

APPENDIX I

Habitat Assessment Criteria

The scores for the ten categories in the habitat assessment were determined by using the following criteria. The interpretation of score was based on Plafkin et al. 1989 methods. The stream scores are relative among the study streams.

INSTREAM

Substrate: The number of available instream substrate types providing habitat diversity were observed and counted. (Mineral, macrophyte, mosses, woody debris and debris pools).

The mineral substrate size classes were evaluated as to diversity of sizes.

The available instream substrate was evaluated for embeddedness.

CHANNEL MORPHOLOGY

Channel shape was evaluated by using the width/depth ratio and sinuosity features.

The alteration score was determined by absence of anthropogenic channelization.

Bank stability was determined by the percentage of adjacent right and left banks that were covered or stabilized by vegetation and boulders, etc.

Complexity scores were determined by presence and formation of riffles, pools and cascades, plus the number of repeated habitat units in the study reach. More complexity received a higher score.

RIPARIAN

Diversity was determined by observing the tree, shrub and other plant species richness in the riparian zone.

The natural category was determined by the percentage of plants that appeared to be original vegetation for that particular site.

The status was scored highest for climax, original plant communities.

APPENDIX II
List of Taxa Found by Stream

Stream: Twin Creek

Cinygmula sp.
Yoraperla brevis
Zapada columbiana
Setvena bradleyi
Sweltsa sp.
Ametor latus
Heterlimnius corpulentis
Lara avara avara
Chyranda centralis
Pycnopsyche sp.
Cryptochia pilosa
Neophylax sp.
Micrasema sp.
Arctopsyche grandis
Lepidostoma sp.
Limnophila sp.
Rhabdomastix sp.
Orthocladiinae
Tanypodinae
Chironominae
Oreogeton sp.
Hydracarina
Gyrulus sp.
Lumbriculidae

Stream: Noname Shoshone Tributary

Ameletus similor
Baetis bicaudatus
Cinygmula sp.
Epeorus longimanus
Epeorus albertae
Drunella doddsi
Yoraperla brevis
Zapada columbiana
Visoka cataractae
Skwala sp.
Setvena bradleyi
Kogotus nonus
Sweltsa sp.
Kathroperla sp.
Paraperla sp.
Neaviperla forcipata
Dexpaxia augusta
Paraleuctra sp.
Amphizoa sp.
Cleptelmis sp.
Chyranda centralis
Cryptochia pilosa
Neophylax sp.
Micrasema sp.

Dicosmoecus sp.
Neothremma sp.
Eocosmoecus sp.
Rhyacophila vaccua
Rhyacophila vagrita
Arctopsyche grandis
Lepidostoma sp.
Glossosoma sp.
Pedicia sp.
Orthocladiinae
Tanypodinae
Glutops rossi
Hydracarina
Polycelis coronata
Oligochaeta

Stream: Canyon Creek

Ameletus similor
Baetis bicaudatis
Cinygma integrum
Cinygmula sp.
Epeorus albertae
Drunella flavilinea
Yoraperla brevis
Zapada columbiana
Visoka cataractae
Isoperla sobria
Setvena bradleyi
Sweltsa sp.
Despaxia augusta
Paraleuctra sp.
Amphizoa sp.
Psychoglypha sp.
Imania sp.
Pycnopsyche sp.
Cryptochia pilosa
Neothremma sp.
Wormaldia sp.
Rhyacophila verrula
Rhyacophila hyalinata
Parapsyche elsis
Dicranota sp.
Dixa sp.
Orthocladiinae
Tanypodinae
Chironominae
Simulium sp.
Glutops rossi
Hydracarina
Oligochaeta

APPENDIX III

List of Taxa Found by Stream and listed by specific habitat.

Stream: Twin Creek: Habitat: CPOM

Cinygmula sp.
Yoraperla brevis
Zapada columbiana
Sweltsa sp.
Despaxia augusta
Ametor latus
Pycnopsyche sp.
Cryptochia pilosa
Micrasema sp.
Arctopsyche grandis
Limnophila sp.
Rhabdomastix sp.
Tanypodinae
Oreogeton sp.
Lumbriculidae

Stream: Shoshone Tributary Creek: Habitat: CPOM

Yoraperla brevis
Zapada columbiana
Visoka cataractae
Sweltsa sp.
Chyranda centralis
Cryptochia pilosa
Micrasema sp.
Dicosmoecus sp.
Lepidostoma sp.
Pedicia sp.
Orthocladiinae
Tanypodinae

Stream: Canyon Creek: Habitat: CPOM

Cinygma integrum
Yoraperla brevis
Zapada columbiana
Visoka cataractae
Isoperla sobria
Setvena bradleyi
Sweltsa sp.
Amphizoa sp.
Imania sp.
Pycnopsyche sp.
Neothremma sp.
Wormaldia sp.
Parapsyche elsis
Dicranota sp.
Dixa sp.
Orthocladiinae
Tanypodinae
Simulium sp.
Hydracarina
Oligochaeta

Stream: Twin Creek: Habitat: pool

Sweltsa sp.
Despaxia augusta
Heterlimnius corpulentis
Lara avara avara
Cryptochia pilosa
Neophylax sp.
Lepidostoma sp.
Limnophila sp.
Rhabdomastix sp.
Tanypodinae
Oreogeton sp.
Hydracarina
Gyrulus sp.

Stream: Shoshone Tributary Creek: Habitat: pool

Ameletus similor
Baetis bicaudatis
Setvena bradleyi
Arctopsyche grandis
Glossosoma sp.
Orthocladiinae
Tanypodinae

Stream: Canyon Creek: Habitat: pool

Ameletus similor
Cinygma integrum
Cinygmula sp.
Yoraperla brevis
Sweltsa sp.
Psychoglypha sp.
Imania sp.
Neothremma sp.
Orthocladiinae
Tanypodinae
Chironominae
Hydracarina

Stream: Twin Creek: Habitat: riffle

Yoraperla brevis
Zapada columbiana
Setvena bradleyi
Sweltsa sp.
Despaxia augusta
Heterlimnius corpulentis
Lara avara avara
Chyranda centralis
Pycnopsyche sp.
Cryptochia pilosa
Lepidostoma sp.
Orthoclaadiinae
Tanypodinae
Chironominae
Oreogeton sp.
Lumbriculidae

Stream: Shoshone Tributary Creek: Habitat: riffle

Baetis bicaudatus
Cinygmula sp.
Epeorus longimanus
Epeorus albertae
Drunella doddsi
Yoraperla brevis
Zapada columbiana
Visoka cataractae
Skwala sp.
Setvena bradleyi
Kogotus nonus
Sweltsa sp.
Kathroperla sp.
Paraperla sp.
Neaviperla forcipata
Paraleuctra sp.
Amphizoa sp.
Cleptelmis sp.
Neophylax sp.
Dicosmoecus sp.
Neothremma sp.
Eocosmoecus sp.
Rhyacophila vaccua
Rhyacophila vagrita
Arctopsyche grandis
Glossosoma sp.
Dicranota sp.
Orthoclaadiinae
Glutops rossi
Hydracarina
Polycelis coronata
Oligochaeta

Stream: Canyon Creek: Habitat: riffle

Ameletus similor
Baetis bicaudatus
Cinygmula sp.
Epeorus albertae
Drunella flavilinea
Yoraperla brevis
Zapada columbiana
Visoka cataractae
Isoperla sobria
Setvena bradleyi
Sweltsa sp.
Despaxia augusta
Paraleuctra sp.
Imania sp.
Pycnopsyche sp.
Cryptochia pilosa
Neothremma sp.
Wormaldia sp.
Rhyacophila verrula
Rhyacophila hyalinata
Parapsyche elsis
Dicranota sp.
Orthoclaadiinae
Tanypodinae
Chironominae
Simulium sp.
Glutops rossi
Oligochaeta

APPENDIX IV

Biological metric values for samples taken in July 1993, Twin Creek, Shoshone Tributary Creek and Canyon Creek. Individual samples are listed by habitat.

*	1	2	3	4	5	6	7	8	9	10
Twin Creek										
Riffle										
93071811	37	11	1.83	0.54	5	2.11	0.68	0.00	0.11	0.22
93071811	14	6	1.54	0.57	4	1.71	0.71	0.00	0.07	0.21
93071811	23	7	1.83	0.41	5	3.39	0.39	0.00	0.39	0.22
93071811	14	6	1.57	0.33	3	3.36	0.43	0.00	0.50	0.07
93071811	29	6	1.58	0.53	4	2.24	0.79	0.00	0.17	0.03
Pool										
93071822	12	8	1.98	0.03	1	4.75	0.00	0.08	0.42	0.42
93071822	9	4	1.15	0.22	2	3.22	0.11	0.00	0.11	0.78
93071822	8	2	0.69	0.33	2	0.50	0.50	0.00	0.00	0.50
93071822	24	5	1.56	0.44	4	1.67	0.50	0.00	0.00	0.50
93071822	8	2	0.69	0.00	0	4.00	0.00	0.00	0.50	0.50
Margin/CPOM										
93071833	32	9	1.38	0.78	5	2.72	0.69	0.03	0.06	0.22
93071833	43	5	0.84	0.30	3	2.12	0.81	0.00	0.00	0.19
93071833	26	8	1.74	0.44	4	2.50	0.50	0.00	0.00	0.42
93071833	18	5	1.23	0.59	3	2.06	0.67	0.00	0.06	0.28
93071833	20	3	0.73	0.67	3	1.75	0.90	0.00	0.00	0.10

Appendix IV Continued.

*	1	2	3	4	5	6	7	8	9	10
Shoshone Tributary Creek										
Riffle										
93071911	56	18	2.53	0.98	17	1.39	0.07	0.34	0.04	0.54
93071911	27	8	1.88	0.96	7	1.37	0.33	0.30	0.00	0.37
93071911	43	17	2.64	0.93	15	1.53	0.37	0.28	0.02	0.28
93071911	53	17	2.36	0.92	14	1.83	0.25	0.09	0.19	0.43
93071911	36	16	2.56	0.72	11	2.61	0.22	0.17	0.19	0.36
Pool										
93071922	11	3	0.76	0.67	3	0.55	0.00	0.73	0.18	0.00
93071922	9	2	0.64	0.22	1	2.67	0.00	0.67	0.00	0.00
93071922	32	6	1.01	0.88	4	1.25	0.00	0.72	0.13	0.03
93071922	11	5	1.41	0.82	4	2.00	0.00	0.45	0.09	0.09
93071922	1	1	0.00	0.33	1	2.00	0.00	0.00	0.00	0.00
Margin/CPOM										
93071933	17	5	1.39	0.67	5	1.18	0.53	0.00	0.00	0.47
93071933	18	3	0.78	0.59	2	1.78	0.17	0.00	0.00	0.72
93071933	33	7	1.04	0.57	4	1.85	0.12	0.00	0.03	0.76
93071933	27	8	1.87	0.59	7	1.30	0.56	0.00	0.00	0.44
93071933	50	11	1.94	0.57	8	1.56	0.48	0.00	0.04	0.46

Appendix IV Continued.

*										
	1	2	3	4	5	6	7	8	9	10
Canyon Creek										
Riffle										
93072111	191	22	2.28	0.97	19	1.73	0.46	0.28	0.04	0.14
93072111	206	22	2.37	0.97	18	1.68	0.46	0.29	0.06	0.14
93072111	121	17	2.24	0.97	15	1.69	0.55	0.19	0.03	0.18
93072111	157	20	2.10	0.97	17	2.08	0.57	0.18	0.04	0.18
93072111	202	25****		0.97	19	1.96	0.51	0.24	0.04	0.17
Pool										
93072122	29	3	0.40	0.67	3	1.17	0.00	0.97	0.03	0.00
93072122	30	8	1.22	0.87	4	2.03	0.00	0.83	0.07	0.07
93072122	17	2	0.22	0.33	2	1.00	0.00	0.94	0.00	0.00
93072122	5	1	0.00	0.33	1	1.00	0.00	1.00	0.00	0.00
93072122	24	5	0.87	0.96	4	1.63	0.04	0.88	0.04	0.04
Margin/CPOM										
93072133	11	6	1.64	0.27	4	2.45	0.73	0.00	0.09	0.09
93072133	2	1	0.00	0.33	1	1.00	1.00	0.00	0.00	0.00
93072133	33	15	2.56	0.70	10	2.18	0.33	0.24	0.18	0.18
93072133	27	13	2.40	0.52	10	1.59	0.33	0.11	0.19	0.33
93072133	21	8	1.95	0.14	2	2.76	0.43	0.00	0.24	0.29

*Appendix IV Criteria

1. Relative abundance collected in D-Nets.
2. Number of species present in sample.
3. Shannon/Wiener species diversity.
4. Percent of sample consisting of Ephemeroptera, Plecoptera and Trichoptera (generally considered indicators of good condition).
5. Number of species in the orders Ephemeroptera, Plecoptera and Trichoptera.
6. Hilsenhoff Biotic Index, lower values indicate higher ecological conditions.
7. Percent of sample from the trophic guild of shredders.
8. Percent of sample from the trophic guild of scrapers.
9. Percent of sample from the trophic guild of collectors.
10. Percent of sample from the trophic guild of predators.

APPENDIX V

MACROINVERTEBRATES COLLECTED BY SAMPLE

TWIN CREEK RIFFLE

Number: SAMPLE 539

- 10 *Yoraperla brevis*
- 13 *Zapada columbiana*
- 5 *Sweltsa*
- 1 *Despaxia augusta*
- 1 *Heterlimnius corpulentis*
- 1 *Lara avara avara*
- 1 *Chyranda centralis*
- 1 *Orthocladiinae*
- 1 *Tanypodinae*
- 1 *Chironominae*
- 2 *Oreogeton*

Number: SAMPLE 540

- 6 *Zapada columbiana*
- 2 *Sweltsa*
- 1 *Despaxia augusta*
- 3 *Chyranda centralis*
- 1 *Chironominae*
- 1 *Oreogeton*

Number: SAMPLE 541

- 2 *Yoraperla brevis*
- 3 *Zapada columbiana*
- 5 *Sweltsa*
- 1 *Despaxia augusta*
- 3 *Chyranda centralis*
- 6 *Orthocladiinae*
- 3 *Chironominae*

Number: SAMPLE 542

- 5 *Zapada columbiana*
- 1 *Sweltsa*
- 4 *Heterlimnius corpulentis*
- 1 *Pycnopsyche*
- 2 *Chironominae*

1 *Lumbriculidae*

Number: SAMPLE 543

- 11 *Yoraperla brevis*
- 6 *Chyranda centralis*
- 3 *Cryptochia pilosa*
- 3 *Lepidostoma*
- 5 *Orthocladiinae*
- 1 *Oreogeton*

TWIN CREEK POOL

Number: SAMPLE 544

- 1 *Sweltsa*
- 3 *Heterlimnius corpulentis*
- 2 *Lara avara avara*
- 1 *Rhabdomastix*
- 1 *Tanypodinae*
- 2 *Oreogeton*
- 1 *Hydracarina*
- 1 *Gyralus*

Number: SAMPLE 545

- 2 *Sweltsa*
- 1 *Heterlimnius corpulentis*
- 1 *Neophylax*
- 5 *Limnophila*

Number: SAMPLE 546

- 4 *Sweltsa*
- 4 *Despaxia augusta*

Number: SAMPLE 547

- 4 *Sweltsa*
- 4 *Despaxia augusta*
- 4 *Cryptochia pilosa*
- 4 *Lepidostoma*
- 8 *Limnophila*

Number: SAMPLE 548
4 *Lara avara avara*
4 *Limnophila*

TWIN CREEK CPOM

Number: SAMPLE 549
1 *Cinygmula*
20 *Yoraperla brevis*
2 *Zapada columbiana*
1 *Sweltsa*
4 *Ametor latus*
1 *Arctopsyche grandis*
1 *Limnophila*
1 *Tanypodinae*
1 *Lumbriculidae*

Number: SAMPLE 550
33 *Yoraperla brevis*
2 *Zapada columbiana*
4 *Sweltsa*
3 *Ametor latus*
1 *Limnophila*

Number: SAMPLE 551
11 *Yoraperla brevis*
4 *Sweltsa*
1 *Despaxia augusta*
3 *Ametor latus*
1 *Cryptochia pilosa*
2 *Limnophila*
2 *Rhabdomastix*
2 *Oreogeton*

Number: SAMPLE 552
10 *Yoraperla brevis*
4 *Sweltsa*
1 *Ametor latus*
2 *Micrasema*
1 *Lumbriculidae*

Number: SAMPLE 553
15 *Yoraperla brevis*
2 *Sweltsa*
3 *Pycnopsyche*

SHOSHONE TRIBUTARY RIFFLE

Number: SAMPLE 554
1 *Baetis bicaudatus*
9 *Cinygmula*
3 *Epeorus longimanus*
2 *Epeorus albertae*
2 *Drunella doddsi*
1 *Yoraperla brevis*
2 *Visoka*
2 *Skwala*
2 *Setvena bradleyi*
1 *Kogotus nonus*
13 *Sweltsa*
1 *Neophylax*
1 *Neothremma*
5 *Rhyacophila vaccua*
4 *Rhyacophila vagrita*
2 *Arctopsyche grandis*
4 *Glossosoma*
1 *Polycelis coronata*

Number: SAMPLE 555
2 *Cinygmula*
2 *Yoraperla brevis*
9 *Sweltsa*
4 *Despaxia augusta*
3 *Neophylax*
4 *Neothremma*
2 *Glossosoma*
1 *Dicranota*

Number: SAMPLE 556
2 *Baetis bicaudatus*
3 *Cinygmula*
1 *Epeorus longimanus*
6 *Yoraperla brevis*
2 *Zapada columbiana*
3 *Visoka cataractae*
1 *Setvena bradleyi*
4 *Sweltsa*
2 *Neaviperla forcipata*
1 *Paraleuctra*
1 *Cleptelmis*
2 *Neophylax*

2 Dicosmoecus
7 Neothremma
3 Rhyacophila vaccua
1 Glossosoma
2 Dicranota

Number: SAMPLE 557

2 Baetis bicaudatis
4 Cinygmula
1 Drunella doddsi
9 Yoraperla brevis
1 Zapada columbiana
3 Setvena bradleyi
15 Sweltsa
2 Kathroperla
1 Paraperla
2 Despaxia augusta
1 Amphizoa
2 Cleptelmis
1 Neophylax
1 Neothremma
1 Rhyacophila vagrita
6 Arctopsyche grandis
1 Glutops rossi

Number: SAMPLE 558

2 Baetis bicaudatis
3 Cinygmula
3 Epeorus albertae
2 Drunella doddsi
2 Yoraperla brevis
1 Setvena bradleyi
1 Kogotus nonus
6 Sweltsa
1 Despaxia augusta
2 Neophylax
3 Dicosmoecus
6 Orthocladiinae
1 Glutops rossi
1 Hydracarina
1 Polycelis coronata
1 Oligochaeta

SHOSHONE TRIBUTARY POOL

Number: SAMPLE 559

1 Baetis bicaudatis
2 Arctopsyche grandis
8 Glossosoma

Number: SAMPLE 560

6 Glossosoma
3 Tanypodinae

Number: SAMPLE 561

1 Baetis bicaudatis
1 Setvena bradleyi
3 Arctopsyche grandis
23 Glossosoma
1 Orthocladiinae
3 Tanypodinae

Number: SAMPLE 562

1 Ameletus similor
2 Baetis bicaudatis
1 Setvena bradleyi
5 Glossosoma
2 Tanypodinae

Number: SAMPLE 563

1 Baetis bicaudatis

SHOSHONE TRIBUTARY CPOM

Number: SAMPLE 564

3 Yoraperla brevis
3 Zapada columbiana
1 Visoka cataractae
8 Sweltsa
2 Lepidostoma

Number: SAMPLE 565

13 Sweltsa
3 Chyranda centralis
2 Tanypodinae

Number: SAMPLE 566

1 Zapada columbiana
2 Visoka cataractae
24 Sweltsa
1 Lepidostoma
1 Dicranota

1 *Orthocladiinae*

3 *Tanypodinae*

Number: SAMPLE 567

5 *Yoraperla brevis*

2 *Zapada columbiana*

9 *Sweltsa*

2 *Chyranda centralis*

3 *Cryptochia pilosa*

1 *Micrasema*

2 *Lepidostoma*

3 *Dicranota*

Number: SAMPLE 568

9 *Yoraperla brevis*

4 *Zapada columbiana*

1 *Visoka cataractae*

19 *Sweltsa*

1 *Chyranda centralis*

4 *Cryptochia pilosa*

2 *Dicosmoecus*

3 *Lepidostoma*

4 *Dicranota*

2 *Orthocladiinae*

1 *Tanypodinae*

CANYON CREEK RIFFLE

Number: SAMPLE 570

2 *Ameletus similor*

11 *Baetis bicaudatis*

11 *Cinygmula*

3 *Drunella flavilinea*

65 *Yoraperla brevis*

7 *Zapada columbiana*

9 *Visoka cataractae*

2 *Isoperla sobria*

14 *Setvena bradleyi*

2 *Sweltsa*

4 *Despaxia augusta*

3 *Paraleuctra*

2 *Imania*

1 *Pycnopsyche*

38 *Neothremma*

2 *Eocosmoecus*

2 *Wormaldia*

4 *Rhyacophila verrula*

4 *Parapsyche elsis*

1 *Dicranota*

1 *Tanypodinae*

3 *Simulium*

Number: SAMPLE 571

8 *Ameletus similor*

10 *Baetis bicaudatis*

16 *Cinygmula*

54 *Yoraperla brevis*

18 *Zapada columbiana*

11 *Visoka cataractae*

6 *Isoperla sobria*

8 *Setvena bradleyi*

9 *Sweltsa*

1 *Despaxia augusta*

1 *Paraleuctra*

1 *Imania*

7 *Pycnopsyche*

2 *Cryptochia pilosa*

43 *Neothremma*

1 *Rhyacophila verrula*

1 *Rhyacophila hyalinata*

3 *Parapsyche elsis*

1 *Dicranota*

3 *Orthocladiinae*

1 *Simulium*

1 *Oligochaeta*

Number: SAMPLE 572

5 *Baetis bicaudatis*

5 *Cinygmula*

2 *Epeorus albertae*

43 *Yoraperla brevis*

12 *Zapada columbiana*

7 *Visoka cataractae*

2 *Isoperla sobria*

8 *Setvena bradleyi*

7 *Sweltsa*

3 *Despaxia augusta*

2 *Pycnopsyche*

16 *Neothremma*

2 *Wormaldia*

2 *Rhyacophila verrula*

- 1 Parapsyche elsis
- 2 Dicranota
- 2 Oligochaeta

Number: SAMPLE 573

- 1 Ameletus similor
- 4 Baetis bicaudatis
- 19 Cinygmula
- 1 Epeorus albertae
- 1 Drunella flavilinea
- 68 Yoraperla brevis
- 11 Zapada columbiana
- 3 Visoka cataractae
- 5 Isoperla sobria
- 15 Setvena bradleyi
- 4 Sweltsa
- 4 Despaxia augusta
- 1 Paraleuctra
- 3 Pycnopsyche
- 8 Neothremma
- 2 Wormaldia
- 3 Parapsyche elsis
- 2 Chironominae
- 1 Simulium
- 1 Glutops rossi

Number: SAMPLE 574

- 3 Ameletus similor
- 6 Baetis bicaudatis
- 22 Cinygmula
- 1 Epeorus albertae
- 2 Drunella flavilinea
- 78 Yoraperla brevis
- 8 Zapada columbiana
- 9 Visoka cataractae
- 3 Isoperla sobria
- 11 Setvena bradleyi
- 13 Sweltsa
- 2 Despaxia augusta
- 2 Imania
- 6 Pycnopsyche
- 1 Cryptochia pilosa
- 21 Neothremma
- 1 Wormaldia
- 2 Rhyacophila verrula

- 4 Parapsyche elsis
- 2 Dicranota
- 0 Orthoclaadiinae
- 1 Tanypodinae
- 1 Chironominae
- 2 Simulium
- 1 Oligochaeta

CANYON CREEK POOL

Number: SAMPLE 575

- 1 Ameletus similor
- 2 Cinygmula
- 26 Neothremma

Number SAMPLE 576

- 4 Cinygma integrum
- 1 Sweltsa
- 1 Imania
- 20 Neothremma
- 1 Orthoclaadiinae
- 1 Tanypodinae
- 1 Chironominae
- 1 Arthropoda: Hydracarina

Number SAMPLE 577

- 1 Psychoglypha
- 16 Neothremma

Number SAMPLE 578

- 5 Neothremma

Number SAMPLE 579

- 3 Cinygmula
- 1 Yoraperla brevis
- 1 Sweltsa
- 18 Neothremma
- 1 Orthoclaadiinae

CANYON CREEK CPOM

Number SAMPLE 580

- 2 Yoraperla brevis
- 2 Zapada columbiana
- 4 Visoka cataractae
- 1 Isoperla sobria
- 1 Tanypodinae

1 Simulium

2 Oligochaeta

Number SAMPLE 581

2 Pycnopsyche

Number SAMPLE 582

1 Cinygma integrum
1 Yoraperla brevis
3 Zapada columbiana
5 Visoka cataractae
2 Sweltsa
2 Imania
2 Pycnopsyche
5 Neothremma
1 Wormaldia
1 Parapsyche elsis
2 Dicranota
3 Dixa
2 Orthocladiinae
2 Tanypodinae
1 Hydracarina

Number SAMPLE 583

1 Yoraperla brevis
4 Zapada columbiana
3 Visoka cataractae
3 Isoperla sobria
1 Setvena bradleyi
3 Sweltsa
3 Imania
1 Pycnopsyche
1 Wormaldia
1 Parapsyche elsis
1 Dicranota
4 Dixa
1 Tanypodinae

Number SAMPLE 584

5 Zapada columbiana
4 Visoka cataractae
3 Amphizoa
3 Dicranota
2 Dixa
1 Orthocladiinae
1 Tanypodinae